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COMPLETE SPECIFICATION

A Propellant Explosive and method of making the same

We, RECHERCHES CHIMIQUES, SOCIETE ANONYME, a body corporate organised under the laws of Belgium, of Brussels, Belgium, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an explosive and to a method of making the same, and more particularly, it relates to an explosive, the effectiveness of which will remain substantially stable over a wide range of temperatures.

In armament technique it is generally considered disadvantageous that the ballistic effect of propellent charges depends to a considerable extent on the temperature of the propellent charge. If, at the time of firing, the propellent charge is at a temperature higher than normal, a higher initial or muzzle velocity and a higher gas pressure is produced by the same charge, whilst a correspondingly reverse effect occurs when the charge is at a temperature, lower than the normal temperature.

The gas pressure obtained at the highest expected temperature is the determining factor for the construction and consequently for the weight of the gun. Thus, a heavier construction is required than would be necessary for firing at the normal or standard temperature of the explosive charge. On the other hand, when the propellent charge is fired at low temperatures, the resulting low gas pressure will cause difficulties, particularly in the case of automatic weapons the function of which is controlled by the gas pressure.

Deviations in the initial velocity, will cause deviations in the range of the artillery projectile, and thus, the temperature of the propellent charge has to be taken into account by correspondingly changing the barrel elevation and the timing of the ignition. Thus, complications and additional sources of error are introduced by the temperature dependency of the propellent charge.

The degree of influence of the temperature of the propellent charge on its effectiveness as above discussed, is defined as the temperature coefficient of the propellent charge. Depending on the type of gun and on the composition of the charge, the temperature coefficient is equal to about between 0.3% and 0.8% of the gas pressure and to between 0.1% and 0.2% of the initial velocity of the projectile, per degree Celsius deviation from the standardised or agreed normal value which may for instance be plus 10° C. The foregoing relationships apply for the conventional smokeless powders.

Smokeless powders have been produced which consist of a mixture of nitrocellulose and nitric acid esters of polyhydric alcohols. The mixture is processed in conventional manner so that each particle of the propellent charge contains a substantially even mixture of these two main constituents throughout. The temperature coefficient of propellent charges made of a mixture of nitrocellulose and nitric acid esters of polyhydric alcohols are within the above described range of from 0.3% to 0.8% for the gas pressure and of from 0.1% to 0.2% for the projectile velocity. It is also known to cover shaped particles of an explosive charge which consist essentially of nitrocellulose, by suitable surface treatment with desensitising substances. Thus, coatings were applied to propellent charges formed by gelatinising or extrusion of nitrocellulose powders. Suitable desensitisers are for instance symmetrical diethyl urea, phthalic acid esters such as diethylphthalate or dibutylpthalate or camphor, each of these substances alone or mixtures thereof, in the latter case also in combination with dinitrotoluene or trinitrotoluene. The purpose of such surface treatment of the propellent charge is to reduce the combustion speed of the powder particles in the initial stage of the firing in order to avoid a high gas pressure peak.

However, none of the prior art modifications of the propellent charge achieves a sub-

stantial reduction in the temperature coefficient of the same.

It is therefore an object of the present invention to provide a propellent charge and a method of making the same, which will overcome the aforementioned disadvantages.

It is another object of the present invention to provide a propellent charge which will give about the same gas pressure and initial velocity of the projectile over a wide range of temperatures.

It is yet another object of the present invention to provide a method by which a propellent charge having a very low temperature coefficient can be produced in a simple and economical manner.

Other objects and advantages of the present invention will become apparent from the further reading of the description and the appended claims.

With the above and other objects in view, the present invention provides a particulate explosive, wherein each particle thereof has an inner portion comprising a smokeless powder, and an outer portion containing at least one nitric acid ester of an aliphatic polyhydric alcohol (as hereinafter defined), preferably in a quantity equal to between 4% and 24% of the weight of said smokeless powder, and a desensitiser.

The present invention also provides a method of producing a particular exposive having a relatively low temperature coefficient upon combustion of the same, wherein the surface of particles of a smokeless powder is treated with a solution of at least one nitric acid ester of an aliphatic polyhydric alcohol (as hereinafter defined) and with a desensitiser so as to adhere at least the nitric acid ester of said polyhydric alcohol to the surface of the particulate smokeless powder.

According to a preferred embodiment of the method of the present invention the solvent for said solution is one in which the smokeless powder is insoluble. The solvent is then removed, preferably by evaporation so as to form a coating of the nitric acid ester of the aliphatic polyhydric alcohol and of the desensitiser on the surface of the particulate smokeless powder, and the thus coated particles are washed with water and dried.

Thus, the present invention solves the problem of producing a smokeless propellent charge which possesses a low temperature coefficient by treating a conventionally produced particulate smokeless powder on the surface of its individual particles with nitric acid esters of aliphatic polyhydric alcohols. Surprisingly it has been found that it is possible in this manner to produce a smokeless powder which possesses a considerably lower temperature coefficient than the so far known smokeless powders. Preferably, the main ingredient of the smokeless powder according to the present invention is a nitrocellulose. The powder is first produced in conventional manner from a nitrocellulose mass, for instance by gelatinisation with suitable solvents, extruding, cutting, sifting, polishing and drying in order to evaporate the solvent. In this manner, individual powder particles for instance in the shape of rods of circular cross section or in the shape of small tubes with one or more longitudinal perforations, or in the shape of strips and platelets of such dimensions are produced as are particularly suitable for the type of gun for which the charge is destined. The thus obtained particulate nitrocellulose charge is then treated with nitric acid esters of aliphatic polyhydric alcohols, preferably in such a manner that the preshaped powder is coated with the nitric acid ester while in a heatable rotating drum. It is preferred for greater ease of handling and more even distribution of the nitric acid ester, to dissolve the same in a volatile solvent such as alcohol. However, a solvent has to be chosen in which the nitric acid ester of the polyhydric alcohol is soluble, which, however, will not dissolve the nitrocellulose powder particles, or at most will dissolve the same only to a very small degree. The solvent is then removed either during the surface treatment of the powder particles by suitable heating, or subsequent thereto by drying. If desired or necessary, this surface treating process can be repeated several times. It has been found advantageous to wash the treated powder with water after removal of the solvent. The washing with water is preferably carried out at elevated temperature, and subsequently, the thus treated powder particles.

The quantity of nitric acid esters of aliphatic polyhydric alcohols which in such manner are to be applied to the surface of the nitrocellulose powder particles will preferably be kept between four per cent and twenty four per cent of the dry weight of the nitrocellulose particles. Particularly good results are obtained by using as nitric acid esters, nitrate of glycerol, of diethylene glycol, of triethylene glycol, of trimethylol ethane and diethanolnitramine, however, the present invention is not to be considered limited to the above listed nitric acid esters. In this specification the term "nitric" acid ester of an aliphatic polyhydric alcohol" is to be understood to exclude nitrocellulose.

The treatment with desensitising or retading agents can be carried out jointly with the nitric acid ester treatment, by using for instance a common solvent for the nitric acid ester and the retarding agent, which solvent again must not substantially attack the nitrocellulose particles, or, the treatment with desensitising or retarding agents can also be carried out in a separate step subsequent to the treatment of the surface of the nitrocellulose powder particles with a nitric acid ester. Good results are obtained according to the present invention by using as desensitising agents known stabilisers such as symmetrical diethyldiphenyl urea known as

Centralit I, camphor, phthalic acid esters such as diethyl or dibutyl phthalate, dinitrotoluene or trinitrotoluene. The total quantity of these desensitisers which thus may be applied to the powder particles is preferably kept between 0.5% and 12% of the weight of the dry powder mass.

According to the present invention, a considerable reduction of the temperature coefficient is achieved, and consequently, important advantages are connected with the use of an explosive charge according to the present invention. These advantages manifest themselves primarily in the fact that by using an explosive charge according to the present invention, an equal charge under otherwise equal conditions will achieve the same projectile velocities and gas pressures independent of the powder temperature. This is of decisive importance for the accuracy achieved in the firing of artillery shells. As a further advantage, it should be noted that the explosive charge according to the present invention can be produced in equipment which is customarily available in the powder industry, such as rotating drums, washing devices and dryers.

In this manner, a highly advantageous reduction of the temperature coefficient of the propellent charge is achieved which is all the more surprising since no such effect has previously been described in the art.

While the present invention is primarily described herein as an application of nitric acid esters of aliphatic polyhydric alcohols to the surface of particulate nitrocellulose explosives substantially free of nitric acid esters of aliphatic polyhydric alcohols, the same is not to be considered as limited thereto, since it is also in the scope of the present invention to surface treat porous explosive powders or particulate explosives which already have admixed and distributed throughout the particles a nitric acid ester of an aliphatic polyhydric alcohol to the surface of the conventional propellent charge.

The following examples are given only as illustrative of the present invention, the invention however not being limited to the specific details of the examples.

EXAMPLE 1

100 kg. of nitrocellulose charge produced in conventional manner are treated after vacuum drying in a conventional treating drum with a solution of 8 kg. of nitroglycerine plus 4 kg. of dibutyl phthalate dissolved in 50 litres ethanol, in such a manner, that the nitrocellulose powder is sprayed with the solution in several individual portions and then drum-treated at room temperature. After subsequent drying, the thus treated charge is further treated in similar heated drums with a solution of 2 kg. of Centralit I, dissolved in 8 litres of alcohol with simultaneous addition of graphite.

Thereafter, the powder is washed with water and dried in a conventional manner.

EXAMPLE 2

100 kg. of nitrocellulose charge are treated in a first treatment with a solution of 6 kg. of trimethylol ethanetrinitrate plus 2 kg. triglycol dinitrate plus 1 kg. dinitrotoluene, dissolved in 45 litres of ethanol, by being sprayed with the solution in several individual portions, and after drying, the thus treated powder is further treated by being sprayed with a solution of 3 kg. of camphor dissolved in 7 litres of ethanol with simultaneous addition of graphite.

The charge is then finished in conventional manner.

EXAMPLE 3

100 kg. of the nitrocellulose charge are treated as described above with a solution of 10 kg. diethylene glycoldinitrate plus 1 kg. dinitrotoluene plus 3 kg. dibutyl phthalate, dissolved in 45 litres of ethanol. During the spraying of the charge with the solution in several individual portions, the temperature in the polishing drum is slowly raised up to 65° C.

Comparison experiments carried out under otherwise equal production conditions with and without the surface application of nitric acid esters of aliphatic polyhydric alcohols, alone or in combination with surface application of desensitisers, have shown that the explosive charges produced according to the present invention possess for a temperature range of from minus 40° C. to plus 40° C. deviations in the efficiency of the propellent charge according to the present invention are very considerably smaller than in the case of conventional charges.

WHAT WE CLAIM IS:—

1. A method of producing a particulate explosive having a relatively low temperature coefficient upon combustion of the same, wherein the surface of particles of a smokeless powder is treated with a solution of at least one nitric acid ester of an aliphatic polyhydric alcohol (as hereinbefore defined) and with a desensitiser so as to adhere at least said nitric acid ester of said polyhydric alcohol to the surface of said particulate smokeless powder.

2. A method as claimed in Claim 1, in which the solution of the said nitric acid ester of an aliphatic polyhydric alcohol contains between 4 and 24% of the ester based on the weight of the smokeless powder.

3. A method as claimed in Claim 1 or 2, wherein the solvent for said solution is one in which said smokeless powder is insoluble, and wherein, after the treatment, said solvent is removed so as to adhere said nitric acid ester of said polyhydric alcohol to the surface of said particulate smokeless powder.

4. A method as claimed in Claim 3, wherein said solvent is removed by evaporation.

5. A method as claimed in any preceding

claim, wherein the resulting coated particles are washed with water and dried.

6. A method as claimed in any preceding claim, wherein said desensitiser is symmetrical diethyldiphenyl urea, camphor, a phthalic acid ester dinitrotoluene or trinitrotoluene.

7. A method as claimed in any preceding claim, wherein said nitric acid ester of an aliphatic polyhydric alcohol is a nitric acid ester of glycerine, diethylene glycol, triethylene glycol, trimethylolethane or diethanolnitramine.

8. A method of producing a particulate explosive substantially as hereinbefore described in any one of the foregoing examples.

9. A particulate explosive, wherein each particle thereof has an inner portion comprising a smokeless powder, and adhering thereto an outer portion containing at least one nitric acid ester of an aliphatic polyhydric alcohol (as here nbefore defined) and a desensitiser.

10. An explosive as claimed in Claim 9, wherein said nitric acid ester of an aliphatic polyhydric alcohol is present in a quantity equal to between 4% and 24% of the weight of said smokeless powder.

11. An explosive as claimed in Claim 9 or 10, wherein said inner portion is substantially free of nitric acid esters of aliphatic polyhydric alcohols.

12. An explosive as claimed in any one of Claims 9 to 11, wherein said desensitiser is present in a quantity of between 0.5% and 12% of said smokeless powder.

13. A particulate explosive, wherein each particle thereof has an inner portion consisting essentially of a smokeless powder and being substantially free of nitric acid esters of aliphatic polyhydric alcohols (as hereinbefore defined), an intermediate portion consisting essentially of at least one nitric acid ester of an aliphatic polyhydric alcohol in a quantity equal to between 4% and 24% of the weight of said smokeless powder, and an outer portion consisting essentially of a desensitiser in a quantity equal to between 0.5% and 12% of said smokeless powder.

14. An explosive as claimed in any one of Claims 9 to 13, wherein said desensitiser is symmetrical diethyldiphenyl urea, camphor, a phthalic acid ester, dinitrotoluene or trinitrotoluene.

15. An explosive as claimed in any one of Claims 9 to 14, wherein said nitric acid ester of an aliphatic polyhydric alcohol is a nitric acid ester of glycerine, diethylene glycol, triethylene glycol, trimethylolethane, or diethanolnitramine.

16. A particulate explosive substantially as hereinbefore described in any one of the foregoing examples.

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